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1           AIR FILTRATING SELF-PROPELLED UPRIGHT VACUUM CLEANER

2                           FIELD OF THE INVENTION

3           This application claims the benefit of U.S.  
4   Provisional Application No. 60/035,357, filed January 10,  
5   1997.

6           The present invention relates to a self-propelled  
7   upright vacuum cleaner comprising a unique HEPA-rated air  
8   filtration system. The present invention also relates to a  
9   self-propelled upright vacuum cleaner having a thermal cut-  
10  off circuit, a novel air routing configuration within the  
11  unit, and numerous other improvements and features.

12          There is an increasing emphasis upon the cleanliness  
13  of air discharged from vacuum cleaners. Prior artisans  
14  have attempted to provide secondary filters for vacuum  
15  cleaner exhaust air streams. Although satisfactory in most  
16  respects, most known secondary filtering configurations are  
17  difficult to design and incorporate within the vacuum  
18  cleaner, thereby increasing the complexity, manufacturing  
19  time, and cost of the unit. Furthermore, for assemblies  
20  employing replaceable filter elements, there is often  
21  considerable difficulty in replacing the element,  
22  particularly if it is located within the vacuum cleaner.  
23  Accordingly, there is a need for a vacuum cleaner  
24  comprising a secondary filtering assembly that overcomes  
25  the problems of the prior art. It would be particularly  
26  desirable to provide a vacuum cleaner with an easily  
27  replaceable filter element in combination with a sealed air  
28  path so that all air exiting the vacuum cleaner unit  
29  traveled through the filter prior to exiting the vacuum  
30  cleaner.

31          Air leaks from a vacuum cleaner unit, such as leakage  
32  of the exhaust stream around the motor housing into the  
33  environment, not only introduce particulates and  
34  contaminants into the outside environment and thus bypass

1 any secondary filter if so provided, but also decrease the  
2 overall efficiency of the unit. Thus, there is a need for  
3 a vacuum cleaner providing an improved internal air routing  
4 configuration which prevents or at least significantly  
5 minimizes exhaust air leaks in and around the lower  
6 enclosure,, and particularly around the motor housing.

7 It is desirable to provide a sensor and electrical  
8 circuit to stop operation of the vacuum cleaner motor in  
9 the event that the temperature of the motor exceeds a  
10 predetermined temperature. Heating of the motor typically  
11 results from a blocked or plugged filter, or from one or  
12 more objects interfering with the operation of the rotating  
13 brush or floor element. Prior artisans have incorporated  
14 temperature sensors and motor switching circuits in vacuum  
15 cleaners. However, as far as is known, none of the known  
16 sensors and switching circuits utilized in vacuum cleaners  
17 provide an automatic reset feature. That is, all known  
18 vacuum cleaners with on board temperature sensors may be  
19 started immediately after the sensor sufficiently cools.  
20 Although satisfactory in most respects, this configuration  
21 still enables electrical power to be applied to the motor.  
22 This may result in damage to the motor, in the event the  
23 motor is bound or otherwise locked. Accordingly, there is  
24 a need for an improved temperature sensing and motor  
25 interlock circuit whereby a reset operation is performed to  
26 ensure that electrical power is not inadvertently directed  
27 to a locked motor.

28 Self-propelled vacuum cleaners are known. However,  
29 much of the design and engineering efforts directed to such  
30 units are focused upon the drive assembly and vacuuming  
31 function. There remains an opportunity to improve other  
32 aspects of self propelled vacuum cleaners such as their  
33 noise level, electrical safety considerations, life of  
34 components such as the motor bearings, connections for an  
35 accessory hose, and configuration of the operator handle.

#### 36 SUMMARY OF THE INVENTION

37 The present invention achieves all the foregoing

1 objectives and provides in a first aspect, a vacuum cleaner  
2 comprising a housing and a base unit pivotally attached to  
3 each other, a motor and motor housing disposed within the  
4 base unit, a drive assembly also disposed within the base  
5 unit and selectively coupled to the motor, a nested wand  
6 releasably retained along the exterior of the housing, a  
7 lower air conduit extending between the base unit and a  
8 lower end of the wand, and an upper air conduit extending  
9 between an upper end of the wand and a suction chamber  
10 defined within the housing.

11 In another aspect, the present invention provides a  
12 vacuum cleaner comprising a lower base unit, an upper  
13 pivotable enclosure for housing a filter bag, a motor  
14 disposed within the lower base unit, a power cord and  
15 associated electrical conductors defining an electrical  
16 power circuit to the motor, and a thermal cutoff assembly  
17 including a temperature sensor disposed proximate to the  
18 motor for measuring the temperature of the motor, the  
19 thermal cutoff assembly including a switching element in  
20 the electrical power circuit that opens upon the  
21 temperature sensor sensing a temperature greater than a  
22 predetermined temperature setpoint.

23 In yet another embodiment, the present invention  
24 provides a vacuum cleaner comprising a lower base unit, an  
25 upper enclosure for retaining a filter bag, the upper  
26 enclosure defining a suction chamber, and exhaust chamber,  
27 and an exhaust opening providing access from the exterior  
28 of the upper enclosure to the exhaust chamber, a motor and  
29 fan assembly disposed within the upper enclosure and in  
30 airflow communication between the suction chamber and the  
31 exhaust chamber, and a detachable filter assembly that  
32 releasably engages the upper enclosure at or near the  
33 exhaust opening.

34 In yet another aspect, the present invention provides  
35 a vacuum cleaner comprising a lower base enclosure, an  
36 upper enclosure having internal walls dividing the upper  
37 enclosure into a suction chamber, an exhaust chamber, and a  
38 motor chamber, a motor and fan assembly disposed in a

1 shroud which resides in the motor chamber, an air intake  
2 duct extending between the suction chamber and the shroud.  
3 The air intake duct engages either or both the suction  
4 chamber and the shroud along an unsealed interface.

5 According to a further aspect of this invention a  
6 motor and transmission module selectively powers a base  
7 drive wheel and at least the motor of the module is encased  
8 in a shroud. The shroud is connected by an exhaust  
9 passageway to the air flow path leading ultimately to the  
10 final filter.

11 BRIEF DESCRIPTION OF THE DRAWINGS

12 FIG. 1 is a perspective view of a preferred embodiment  
13 vacuum cleaner in accordance with the present invention;

14 FIG. 1A is an exploded view of the preferred  
15 embodiment vacuum cleaner illustrated in FIG. 1;

16 FIG. 1B is a side elevational view of the preferred  
17 embodiment vacuum cleaner illustrated in FIG. 1;

18 FIG. 2 is a partial exploded view of the preferred  
19 embodiment vacuum cleaner housing, illustrating in greater  
20 detail the direction of airflow within the housing;

21 FIG. 2A is a detailed view of the assembled housing  
22 shown in FIG. 2 having a bag cover removed;

23 FIG. 2B is another view of the housing shown in FIG. 2  
24 with the bag cover removed;

25 FIG. 3 is a perspective view of the rear of the  
26 preferred embodiment vacuum cleaner;

27 FIG. 4 is a detailed view illustrating the affixment  
28 of a preferred embodiment detachable filter to the rear  
29 housing of the preferred embodiment vacuum cleaner;

30 FIG. 4A illustrates the filter shown in FIG. 4  
31 attached to the rear housing and the direction of airflow  
32 from the preferred embodiment vacuum cleaner;

33 FIG. 5 is a detail of the preferred embodiment filter  
34 used in the preferred embodiment vacuum cleaner;

1 FIG. 6 is another view of the preferred embodiment  
2 filter;  
3 FIG. 7 is a schematic cross-sectional view of the  
4 preferred embodiment filter illustrating its orientation to  
5 the floor when the preferred embodiment vacuum cleaner is  
6 set to a fully reclined position;  
7 FIG. 8 is an exploded view of a suction motor and a  
8 motor shroud used in the preferred embodiment vacuum  
9 cleaner;  
10 FIG. 9 is a detailed view of the motor shroud shown in  
11 FIG. 8;  
12 FIG. 10. is another detailed view of the motor shroud  
13 shown in FIG. 8;  
14 FIG. 11 is a detailed view of the engagement between a  
15 hose adapter and the housing of the preferred embodiment  
16 vacuum cleaner;  
17 FIG. 11A is an elevational view of the adapter and  
18 housing assembly depicted in FIG. 11;  
19 FIG. 12 is a fragmentary view of the vacuum cleaner  
20 base illustrating the drive module and air flow  
21 therethrough; and  
22 FIG. 13 is a partially cross-sectional view of the  
23 handle assembly.

24 DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 Referring to FIGS. 1, 1A, 1B and 3, a preferred  
26 embodiment vacuum cleaner 10 in accordance with the present  
27 invention is illustrated. The vacuum cleaner 10 comprises  
28 a rear housing 20, an upper front cover 30, a bag cover 80,  
29 and a lower motor cover 50 that generally form the body of  
30 the vacuum cleaner 10. The lower portion of the preferred  
31 embodiment vacuum cleaner 10 comprises an upper base 40  
32 having a front guard 120 and a plurality of wheels  
33 including rear wheels 110. The upper portion of the  
34 preferred embodiment vacuum cleaner 10 further comprises a

1 handle 90, a grip 100, and a side mounted tool caddie  
2 insert 34. Disposed along the rear of the vacuum cleaner  
3 10 is a final filter 60.

4 Referring specifically to FIG. 1A, other components of  
5 the preferred embodiment vacuum 10 are as follows. The  
6 handle 90 is disposed between the front cover 30 and the  
7 upper portion of the rear housing 20. The handle 90  
8 preferably has an arcuate bend proximate to its upper  
9 distal end 91. The bend is such that the distal end 91 is  
10 directed toward the rear of the vacuum cleaner 10. The  
11 grip 100 is affixed to a handle cover 102 and this assembly  
12 is slidably mounted on the upper distal end 91 of the  
13 handle 90. Various switches and controls may also be  
14 provided proximate to the distal end 91 of the handle 90  
15 such as, but not limited to, a neutral lock mechanism 130  
16 and related selector springs 132 and a selector spacer 134.  
17 In addition, one or more switches may be located at the  
18 distal end 91 of the handle 90 for controlling the  
19 operation of the vacuum cleaner 10. Other controls such as  
20 an on/off switch 140 and various potentiometer type  
21 controls such as a slide control 142 are preferably  
22 disposed and affixed to the front cover 30.

23 The upper base 40 and a lower base 180 engage each  
24 other and generally form a lower enclosure that houses the  
25 drive motor and brush assembly as follows. A drive motor  
26 230 is disposed and retained within the enclosure formed by  
27 the upper base 40 and the lower base 180. The drive motor  
28 230 is operatively coupled to a transmission 240 that also  
29 resides within the enclosure formed by the upper and lower  
30 bases 40 and 180. Rotatably secured to, or retained  
31 within, the lower base 180 are a plurality of wheels. A  
32 pair of rear wheels 110 are rotatably affixed to the lower  
33 base 180 by respective axles 111. Disposed proximate the  
34 front of the lower base 180 is a wheel carriage 112 that  
35 rotatably supports a front axle 116 having a pair of front  
36 wheels 114 secured at its ends. Also disposed within the  
37 enclosure formed by the upper base 40 and the lower base

1 180 is a rotatable brush or disturbulator 170. The  
2 disturbulator 170 is rotated by a disturbulator belt 172.  
3 A belt cover 174 is utilized to cover the belt 172.

4 Referring further to FIG. 1A, preferably disposed  
5 proximate to the lower portion of the rear housing 20 are a  
6 suction motor 210 and a motor shroud 220. The suction  
7 motor 210 draws air through the enclosure formed by the  
8 upper and lower bases 40 and 180, i.e. in the vicinity of  
9 the disturbulator 170, through a lower hose 72, a nested  
10 wand 78, an upper hose 70, a bag filter 270 disposed within  
11 a bag chamber described below, a second filter 260, an air  
12 intake duct 250, through the motor shroud 220 and  
13 eventually into the final filter 60 as described in greater  
14 detail below. A single screw is utilized for engaging the  
15 lower hose 72 connector to the lower base 180. A hose  
16 union 74 and other conventional coupling assemblies may be  
17 used to complete the airway. A unique releasably locking  
18 hose adapter 71, described in greater detail below, is  
19 preferably utilized to couple the upper hose 70 to the bag  
20 chamber within the rear housing 20.

21 An electrical power cord 200 and one or more cord  
22 release members 202 are provided along the rear of the  
23 vacuum cleaner 10. The power cord 200 provides electrical  
24 power to the suction motor 210 and the drive motor 230.  
25 The preferred embodiment vacuum cleaner 10 also comprises a  
26 headlight 150 and a lens 152 disposed in or upon the motor  
27 cover 50. A height adjustment assembly and knob 160 is  
28 provided for the lower base unit.

29 The preferred embodiment vacuum cleaner also comprises  
30 a variety of cleaning tools or attachments. A side mounted  
31 tool caddie insert 34 is preferably utilized to releasably  
32 retain these tools such as for instance a crevice tool 190,  
33 an upholstery nozzle 192, and a brush 194. An extension  
34 wand 76 is also provided. An attachment tool is utilized  
35 by detaching the hose 70 from the nested wand 78 at their  
36 coupling along the rear of the vacuum cleaner 10, as best  
37 depicted in FIG. 3. Upon release of the hose 70 from the

1 nested wand 78, one of the previously noted tools 190, 192,  
2 or 194, or the extension wand 76 can be attached to the  
3 free end of the hose 70.

4 Referring to FIG. 1B, another aspect of the preferred  
5 embodiment vacuum cleaner 10 is the orientation of the  
6 upper housing and handle 90 to the base when the vacuum  
7 cleaner 10 is in its stationary upright position. This  
8 position is reached when the vacuum cleaner is placed in  
9 its accessory vacuuming mode. As evident in FIG. 1B, the  
10 upper housing is preferably oriented forward at some angle  
11 X from vertical. This orientation results in a more stable  
12 assembly than if the upper housing were oriented along a  
13 generally vertical axis. This becomes increasingly  
14 important as the bag filter 270 (shown in FIG. 1A) fills up  
15 with dirt and debris, thereby increasing in weight. It is  
16 most preferred that the angle X be about 8-1/2°. The  
17 present invention vacuum cleaners include other  
18 configurations in which the upper housing and handle are  
19 angled forward.

20 Referring further to FIG. 1A, a conventional handle  
21 release 92 and a release spring 94 control the angular  
22 orientation of the upper portion of the vacuum cleaner  
23 housing and handle. The handle 90 and related attachments  
24 such as switches and grips, may be entirely detachable from  
25 the vacuum cleaner 10, or designed to pivot so that the  
26 assembly may be folded downward toward the floor to a  
27 horizontal, or substantially horizontal, position. It is  
28 also contemplated that the handle could be mounted within  
29 the upper portion of the vacuum cleaner body in such a way  
30 that the handle becomes the movable portion or actuator  
31 utilized to control the operation of the vacuum cleaner.  
32 This would eliminate providing selector controls at the end  
33 of the handle 90 such as the selector 130. In this  
34 contemplated embodiment, the linkage connection to the  
35 control cable, i.e. a sheathed transmission shifting cable  
36 described below, would occur within the top portion of the  
37 vacuum cleaner body or housing. In many or all of these



1   embodiments, it is further contemplated that the handle 90  
2   could be designed so that it could be readily removed from  
3   the main housing of the vacuum cleaner. This would  
4   significantly reduce the size of the shipping carton and  
5   reduce shipping costs. Other advantages would likely  
6   include quick customer assembly and reduction in the number  
7   of parts and parts costs. A reduction in the size of  
8   shipping carton and parts would further allow the packaged  
9   product to be more easily displayed in the sometimes  
10  restricted shelf area found in many retail stores.

11       It is also preferred to utilize a tilt switch,  
12  preferably disposed within the handle 90, that prevents  
13  operation of the drive motor 230 depending upon the  
14  position of the handle. Preferably, the switch opens or  
15  closes an electrical control circuit depending upon the  
16  angular orientation of the handle. A switch comprising a  
17  ball bearing and raceway is disposed within the handle 90  
18  and oriented such that when the handle is in an upright  
19  position, the ball bearing rolls or otherwise moves to a  
20  location along the raceway that results in an open  
21  electrical circuit between the switch terminals. The  
22  switch is also oriented so that when the handle is at any  
23  other position than its upright position, i.e. and so  
24  typically at some angle of inclination, the ball bearing  
25  rolls or moves to a location along the raceway that results  
26  in completion of the electrical pathway between the switch  
27  terminals. The tilt switch is preferably utilized in a  
28  control circuit governing operation of the drive motor 230  
29  so that when the handle is in its upright position, the  
30  drive motor 230 will not operate. It is also contemplated  
31  that other types of switches utilizing other types of  
32  movable elements could be used. Furthermore, other types  
33  of interlocking switches could be used to prevent operation  
34  of the drive motor 230 when the handle 90 is in its upright  
35  position. It is envisioned that electrical contacts could  
36  be provided between the tiltable body portion of the vacuum  
37  cleaner and the base portion. The electrically conductive

1 contacts would contact one another only when the handle was  
 2 tilted from its upright position. The contacts would be  
 3 incorporated into an electrical control circuit governing  
 4 operation of the drive motor 230. Moreover, the location  
 5 and placement of the switch could be elsewhere besides the  
 6 handle, such as for instance, within the housing or base  
 7 units of the vacuum cleaner.

8 The various housing, cover, and base components  
 9 described herein can be formed from a wide array of  
 10 materials. A preferred material is molded polyurethane.

11 The preferred embodiment vacuum cleaner 10 utilizes a  
 12 unique and novel filtered airflow system as follows.  
 13 Referring to FIG. 2, upon operation of the suction motor  
 14 210 generally disposed within the motor shroud 220, air is  
 15 drawn through the hose 70 and through the hose adapter 71  
 16 into the bag filter 270. After passing through the walls  
 17 of the bag filter 270, shown as arrow A in FIG. 2, air  
 18 enters a secondary filter 260 located at the inlet of the  
 19 air intake duct 250. Air passes through the air intake  
 20 duct 250 shown as arrow B until it exits the duct 250 at  
 21 the outlet shown as arrow C. The air then enters the inlet  
 22 of the motor shroud 220, shown as arrow D, and then is  
 23 directed through the outlet of the motor shroud 220 shown  
 24 as arrow E. The air is then directed to the final filter  
 25 60 as shown by arrow F. After passing through the final  
 26 filter 60, the air then exits the vacuum cleaner 10 through  
 27 laterally oriented airflow openings along the side of the  
 28 final filter 60 and described in greater detail below. The  
 29 air exits as shown as arrows G.

30 A bag chamber, i.e. an interior region that houses the  
 31 bag filter 270, is formed between the rear housing 20 and  
 32 the bag cover 80. During operation of the vacuum cleaner  
 33 10, the bag chamber is usually at a negative pressure, i.e.  
 34 a pressure less than atmospheric pressure.

35 The preferred embodiment motor shroud 220 generally  
 36 encloses the suction motor 210 and diverts all air through  
 37 the final filter 60. This configuration greatly simplifies

1 gasket design and sealing issues otherwise encountered if a  
2 multi-component housing or shroud assembly was used.  
3 Although a one-piece sealed shroud enclosing the suction  
4 motor is preferred, the present invention includes  
5 additional embodiments including the use of a by-pass duct  
6 located either upstream, downstream, or on both ends of the  
7 suction motor. Other sealed enclosures are contemplated  
8 wherein the sealing is accomplished by conventional  
9 gaskets, adhesives or component welding.

10 In a most preferred embodiment, air leaks are  
11 significantly reduced by recirculating airflow within the  
12 vacuum cleaner housing. Specifically, provisions are made  
13 to prevent exhaust air leaks from escaping to the  
14 environment before passing the air through the final filter  
15 60. This is accomplished by maintaining a negative  
16 pressure inside the vacuum cleaner housing, and  
17 particularly within the enclosure formed between the rear  
18 housing 20 and the bag cover 80. This region of negative  
19 pressure may also extend in the vicinity behind the front  
20 cover 30. Referring to FIGS. 2A and 2B, it is most  
21 preferred to use an ungasketed joint between the air duct  
22 250 and a mounting shelf 252 provided in the rear housing  
23 20. The mounting shelf 252 defines an opening sized to  
24 accept and preferably support an end of the air duct 250.  
25 The interface between the opening and the outer periphery  
26 of the air duct 250 is shown in FIGS. 2A and 2B as  
27 interface 251. This interface is most preferably not  
28 sealed. As a result, exhaust leaks occurring in and around  
29 the upper portion of the air duct 250 are drawn into the  
30 bag chamber. Similarly, by providing an ungasketed joint  
31 between the lower region of the air intake duct 250 and the  
32 inlet of the motor shroud 220, shown in FIG. 2B as joint  
33 224, potential exhaust leaks in and around a gasketed  
34 joint between the lower portion of the air duct 250 and the  
35 suction motor 210 are drawn back into the motor shroud 220.  
36 As can be seen, potential exhaust leaks from the positive  
37 pressure side of the air handling system are recaptured

into the airstream instead of being exhausted to the environment before passing the airstream through the final filter 60. This is achieved by maintaining a negative pressure inside the body or housing of the vacuum cleaner 10. The negative pressure inside the body or housing is due to inherent and/or predetermined leaks between the various airflow handling components which allow air to enter the air intake duct 250 and the bag chamber.

In another preferred embodiment, a flexible conduit shown in FIG. 2A as conduit 253 is provided between the motor bearings and the suction side or negative pressure side of the system. The conduit and resulting air flow through the conduit captures particles and contaminants otherwise leaking through the bearing or around the bearing and into the atmosphere. In the absence of such conduit, particles and contaminants leak from inside the enclosure or motor shroud to the outside environment. Another advantage of providing the flexible conduit 253 is that the resulting airflow therethrough draws air through and around the bearing thereby cooling the bearing and neighboring components. Preferably and with reference to FIGS 2A and 8, the conduit 253 extends from a collar 590 disposed proximate a motor bearing. The conduit 253 extends to a location of lesser pressure, such as within the air duct 250. Other installation sites for the end of the conduit 253 may be utilized instead of the air duct 250. For instance instead of terminating the end of the conduit 253 at the air duct 250, that end could be installed on the shelf 252 so that the conduit 253 is in communication with the region of the enclosure behind the filter wall 300.

The preferred embodiment vacuum cleaner 10 utilizes a HEPA-rated final filter 60 best shown in FIGS. 4, 4A, 5, 6, and 7. The HEPA filter captures at least 99.97% of particles having a diameter of about 0.3 microns. The rear housing 20 is particularly adapted for accommodating the final filter 60. The rear housing 20 preferably comprises a rear wall 390 disposed between transversely extending



1 the final filter 60 is attached to the vacuum cleaner 10.  
 2 A retaining member 480 is preferably utilized to assist in  
 3 releasably retaining the final filter 60 to the vacuum  
 4 cleaner 10. A filter element 490 such as a paper filter  
 5 element, is disposed within the enclosure formed by the  
 6 outer cover plate 400 and the walls 410, 420, 430, and 440.

7 Referring to FIG. 7, during operation of the vacuum  
 8 cleaner 10, air exiting the rear housing 20 flows through  
 9 the filter element 490 and out of the final filter 60, i.e.  
 10 through the airflow openings 460, which direct the air  
 11 laterally outward. The airflow openings 460 are defined  
 12 along the sidewalls 410 and 420. This is desirable,  
 13 particularly when the vacuum cleaner 10 is in a fully  
 14 reclined position such that its upper housing and handle  
 15 are angled downward and near the floor 2. The laterally  
 16 oriented openings 460 direct the exiting air stream away  
 17 from the floor 2. The extent of reclining may be such that  
 18 the handle is approximately horizontal. This orientation  
 19 is useful so that the vacuum cleaner 10 has a low profile  
 20 to thereby enable the vacuum cleaner to be used under  
 21 furniture items and beds.

22 The separate and detachable final filter 60 offers  
 23 additional advantages. By using an external one-piece  
 24 final filter assembly, there is no need for a separate  
 25 housing or cover to house and protect the filter element.  
 26 Furthermore, by utilizing a curved configuration for the  
 27 outer cover plate 400 of the final filter 60, exiting air  
 28 is directed slightly upwards from the floor 2 when the  
 29 vacuum cleaner is in a fully reclined position. This  
 30 further minimizes debris on the carpet from being blown  
 31 with the air. This is illustrated in FIG. 7. The rear  
 32 cover plate 400 further acts as a shield to protect the  
 33 paper filter element 490 and further deaden noise. In yet  
 34 another embodiment, some of the various laterally disposed  
 35 airflow openings 460 located along both sides of the final  
 36 filter 60 can be eliminated and defined on only one side of  
 37 the filter housing.

1 Referring to FIGS. 8, 9, and 10, the motor shroud 220  
2 and suction motor 210 are illustrated in greater detail.  
3 The motor shroud 220 generally encloses the suction motor  
4 210. The motor shroud 220 is preferably cylindrical,  
5 comprising an arcuate wall 540 and an endwall 544. The  
6 motor shroud 220 comprises a tangentially and outwardly  
7 extending air duct 530 defining a shroud opening 510 at its  
8 distal end 531. The air duct 530 is in airflow  
9 communication with the final filter 60 disposed behind the  
10 filter wall 300 as shown in FIG. 2A. The air duct 530 may  
11 be attached to the mounting shelf 252. Preferably provided  
12 proximate to the distal end 531 of the air duct 530 is a  
13 seal seat 532. The seal seat 532 supports a pliable and  
14 flexible seal 520 that reduces air leaks between the  
15 mounting shelf 252 and the air duct 530 of the motor shroud  
16 220. One or more fasteners 570 and bosses 560 are used to  
17 affix and secure the assembly. A sealing and coupling  
18 ring 580 is preferably used between the suction motor 210  
19 and the shroud 220. The assembly of the motor 210, the  
20 ring 580, and the shroud 220 is preferably disposed within  
21 the lower portion of the rear housing 20, and as best shown  
22 in FIG. 2A, against the second sidewall 320 of the rear  
23 housing 20. Most preferably, the assembly is  
24 concentrically aligned with the pivot hub 350 defined in  
25 that sidewall. An alignment and support collar 590 is  
26 preferably utilized, as shown in FIG. 8 to facilitate  
27 support and engagement between the shroud 220 and the pivot  
28 hub 350 in the second sidewall 320.

29 The motor shroud 220 utilizes an interior isolation  
30 wall 500 as shown in FIG. 10. The isolation wall 500  
31 generally blocks access to electrical components of the  
32 suction motor 210 and serves as a sound insulating barrier  
33 to decrease motor noise. Referring also to FIG. 9, the  
34 motor shroud 220 also provides one or more terminal  
35 apertures 550 that provide access to one or more electrical  
36 terminals 212 of the suction motor 210. The preferred  
37 embodiment for forming a seal between the motor terminals





1 temperatures are sensed or an overheat condition occurs.  
 2 Overheating may occur if one or more of the filters 270,  
 3 260 or 60 become blocked or excessively plugged, thereby  
 4 hindering or precluding airflow past the suction motor 210.  
 5 The motor 210 cannot be restarted until the switching  
 6 element cools and the electrical circuit is re-established.  
 7 The electrical circuit is re-established in one of several  
 8 ways such as by unplugging the vacuum cleaner or turning  
 9 the power switch off, and then either plugging in the  
 10 vacuum cleaner or turning the power switch on. The  
 11 positive temperature coefficient characteristic of the  
 12 switching element provides an advantage over conventional  
 13 manual reset thermal cutoff assemblies in that it  
 14 simplifies the design and eliminates parts otherwise  
 15 required such as a restart button and related wiring.

16 Most preferably, the thermal cutoff assembly comprises  
 17 a positive temperature coefficient resistor and a reset  
 18 component. The positive temperature coefficient resistor  
 19 is adapted to switch, at a predetermined temperature such  
 20 as indicative of overheating or a clogged filter, from a  
 21 low resistance to a very high resistance. When the  
 22 positive temperature coefficient resistor switches to a  
 23 high resistance, the cutoff assembly cuts off electric  
 24 power to the motor assembly. The reset component prevents  
 25 the restoration of power to the motor assembly until  
 26 electric power is disconnected from the cutoff assembly,  
 27 such as by unplugging the unit or turning the power switch  
 28 off, and the positive temperature coefficient resistor  
 29 changes back to a low resistance while the unit is  
 30 disconnected. The change to a low resistance occurs as a  
 31 result of sufficient cooling of the positive temperature  
 32 coefficient resistor. Only then may electric power be  
 33 directed to the motor.

34 The preferred embodiment vacuum cleaner 10 utilizes a  
 35 reliable mounting configuration and technique for attaching  
 36 the handle 90 to the upper portion of the vacuum cleaner  
 37 10. Referring to FIG. 1A, the handle 90 is mounted between

1 the upper portion of the rear housing 20 and the front  
2 cover 30. Specifically, the lower region of the handle  
3 proximate to a lower distal end 95 is placed within a  
4 handle cradle 24 provided on the upper interior surface of  
5 the rear housing 20. One or more outwardly extending  
6 mounting posts 26 are provided, preferably along the length  
7 of the mounting cradle 24. It is also preferred to provide  
8 a mounting post 26 at the uppermost region of the rear  
9 housing 20 to further secure the handle 90. One or more  
10 mounting apertures 96 are defined along the lower portion  
11 of the handle 90 such that when the handle 90 is placed  
12 within the cradle 24, the mounting posts 26 are aligned  
13 with the apertures 96 and extend therein. The handle 90 is  
14 secured to the rear housing 20 by attaching the rear cover  
15 30 over the handle 90 disposed and aligned within the  
16 cradle 24. It is also contemplated that a similar cradle  
17 may be provided on the interior surface of the front cover  
18 30, preferably with mounting posts that would engage  
19 additional mounting apertures defined in the handle 90.

20 The preferred embodiment vacuum cleaner 10 utilizes a  
21 transmission control cable configuration substantially as  
22 shown in U.S. Patent no. 4,249,281. Referring to FIGS. 1A,  
23 2B, and 13, it will be noted that the transmission neutral  
24 lock mechanism 130 is disposed on the handle 90 and the  
25 transmission 240 is disposed within the upper and lower  
26 bases 40 and 180, respectively. The handle assembly  
27 comprising the cover 102 and the grip 100 is preferably of  
28 a plastic material and is clamped together by means of  
29 screws 950 and 952. For this purpose suitable slots 954  
30 may be provided on opposite sides of the upper end 91 of  
31 the handle 90 through which losses 956 and 958 extend to  
32 engage one another. This mounting thereby covers the upper  
33 end of the handle 90 and inhibits removal of the handle  
34 assembly therefrom and yet permits the handle assembly to  
35 move slidably axially at the end of the handle 90. This  
36 mounting of course also inhibits relative rotation between  
37 the handle assembly and the handle 90.





1 fitting the end 630 into an aperture 270A in a mounting  
 2 plate 270B provided at the top of the filter 270. The  
 3 mounting plate is retained between the support ledge 620  
 4 and a parallel ledge 620A. The opening 660 may be an  
 5 aperture of circular shape, or may be in the form of a  
 6 notched passageway defined in the support of ledge 620.  
 7 One or more support ribs 650 may be provided to strengthen  
 8 the attachment between the lip 600 and the hose adapter 71.  
 9 The hose adapter 71 is releasably engaged with the rear  
 10 housing 20 by positioning it over the opening 660 such that  
 11 the lip 600 is disposed underneath a locking ledge 640.  
 12 That is, a portion of the lip 600 is disposed between the  
 13 locking ledge 640 and the support ledge 620. The hose  
 14 adapter 71 is then rotated, which due to the action of the  
 15 inclined cam region 610, induces downward displacement of  
 16 the hose adapter 71, and specifically the distal end 630,  
 17 into the opening 660. The lip 600 defines an arcuate edge  
 18 604 extending around at least a portion of the hose adapter  
 19 71. It is preferred to provide a flat region 602 such that  
 20 when the hose adapter 71 is locked into place upon the  
 21 support ledge 620, the flat edge 602 is flush, or at least  
 22 not extending beyond, an outer edge 622 of the support  
 23 ledge 620. The arcuate edge 604 of the lip 600 preferably  
 24 extends radially outward from the hose adapter 71 a  
 25 distance such that when the adapted 71 is not locked into  
 26 place, i.e. and so that the flat edge 602 is not flush with  
 27 the outer edge 622 of the support ledge 620, the arcuate  
 28 edge 604 extends outward beyond the edge 622. This  
 29 prevents the bag cover 80, or other housing component, from  
 30 being fully engaged with the rear housing 20. This unique  
 31 interlock configuration requires that the upper hose 70 be  
 32 properly coupled to the housing of the vacuum cleaner 10.

33 The preferred embodiment vacuum cleaner 10 also  
 34 utilizes a single wheel drive mechanism. The use of a  
 35 single wheel drive mechanism offers improved  
 36 maneuverability, a more economical and less expensive drive  
 37 assembly, simplicity of engaging the transmission to the

1 chassis, versatility of location relative to the cleaning  
2 head or base, and improved serviceability for the vacuum  
3 cleaner.

4 The drive assembly and related gear cluster is  
5 preferably of the type disclosed in U.S. Patent 4,249,281  
6 to Meyer et al., which is herein incorporated by reference.  
7 Furthermore, it is contemplated that the drive motor used  
8 in the preferred embodiment vacuum cleaner 10 could be of  
9 the variable speed type, controlled by an electronic  
10 module, which may be in the form of a diode in series or a  
11 potentiometer. This would enable the drive speed to be  
12 operator adjustable for the pace desired by each individual  
13 user of the vacuum cleaner 10.

14 As may be seen most clearly in FIG. 12, the single  
15 wheel drive mechanism comprising the drive motor 230, the  
16 transmission 240, and associated gear cluster and single  
17 drive wheel preferably disposed and mounted within the  
18 lower base 180. Mounting provisions may be provided on a  
19 side region of the lower base 180, such as the left hand  
20 side of the lower base 180 illustrated in FIGS. 1A and 12.  
21 A drive shaft is used to couple the single drive wheel 241  
22 to the other components of the drive mechanism. Various  
23 supporting and mounting provisions can be provided in the  
24 lower base 180 for rotatably securing the drive shaft and  
25 single drive wheel to the lower base 180. Preferably in  
26 this regard, an "eyebrow" notch is formed in a vertical  
27 wall or rib in the lower base 180, through which the drive  
28 shaft passes. The shaft may be further supported by a  
29 bearing disposed within the notch.

30 It is also contemplated to utilize a clutch in the  
31 drive mechanism. A problem encountered in self-propelled  
32 vacuum cleaners is fracturing or breaking or other failures  
33 in the weakest component in the gear chain. This often  
34 results during unpowered, rolling transport of the vacuum  
35 cleaner, when the user has failed to place the drive  
36 mechanism in neutral. Under these conditions, torque  
37 generated by the drivewheel rolling across the floor is

transmitted through the drive axle to the transmission and eventually to the drive motor. In the event the total gear reduction is relatively high, so that the drive motor will tend to not turn, the weakest component in the gear chain will fail. In order to remedy this problem, a one-way clutch is added to the drive train to disconnect the torque between the transmission and the drive module gear reduction assembly or drive motor.

The drive mechanism utilized in the preferred embodiment vacuum cleaner 10 is assembled by utilizing a unique technique for achieving proper spacing between the legs of a yoke and the drive gear cluster. Referring to the noted U.S. Patent 4,249,281, and particularly to FIGS. 5 and 6 of that patent, a yoke 120 generally encloses the gear cluster. As described in that patent, a plurality of bearing rivets 130 are provided on downwardly extending arms 124 of the yoke 120. These rivets 130 are utilized to effect proper spacing between the yoke arms 124 and the gear cluster. Although the assembly described in the '281 patent is satisfactory in many respects, the present invention provides an improved assembly that is significantly easier to assemble and eliminates the necessity for the bearing rivets 130.

As noted, it is important to achieve proper spacing between the ends of the gear cluster and arms of the yoke. In accordance with the present invention, one or more spacing washers are incorporated in the assembly. The width and placement of the washers are such that the gear cluster is placed into proper position with respect to the yoke arms. During assembly, the yoke and the gear cluster are introduced into a machine that automatically measures the total axial thickness of the gear cluster, and also measures the interior clearance or distance between the yoke arms. Using these two measured distances, one or more spacing washers are then dispensed and preferably appropriately incorporated into the gear cluster to arrive at a proper spacing between the gear cluster and yoke arms.

